We claim:

1. A method for forming a metal pattern in a substrate, the method comprising the steps of:

depositing a lower hardmask layer on the substrate, the lower hardmask layer having a dielectric constant less than about 4.5;

depositing a middle hardmask layer on the lower hardmask layer;

depositing a top hardmask layer on the middle hardmask layer, the top hardmask layer having a thickness less than about 200 Å;

forming a first opening in the top hardmask layer in accordance with a first pattern, thereby exposing a portion of the middle hardmask layer;

forming a second opening in said portion of the middle hardmask layer in accordance with a second pattern and a corresponding opening in the lower hardmask layer, thereby exposing a portion of the substrate;

forming an opening in the substrate;

depositing metal in the opening in the substrate; and

removing the top hardmask layer.

2. A method according to claim 1, wherein the top hardmask layer is of a material selected from the group consisting of refractory metals, refractory metal nitrides, refractory metal alloys, doped amorphous silicon and doped silicon.

3. A method according to claim 1, wherein the middle hardmask layer is of a material selected from the group consisting of SiO_2, SiN, SiON and SiOF.

4. A method according to claim 1, wherein the lower hardmask layer is of a material selected from the group consisting of SiC:H, SiCOH, SiCNH, carbon-doped oxide, organosilicate glass, silicon oxycarbide, amorphous hydrogenated silicon carbide and amorphous hydrogenated silicon carbide/nitride.

5. A method according to claim 1, wherein said step of depositing metal further comprises depositing excess metal overlying the top hardmask layer, and further comprising the step of removing the excess metal by polishing the metal in a chemical-mechanical polishing (CMP) process, a polishing rate of the top hardmask layer being less than a polishing rate of the metal.

6. A method according to claim 1, wherein said step of forming the first opening includes depositing a resist layer on the top hardmask layer and subsequently removing the resist layer therefrom, and wherein the middle hardmask layer protects the lower hardmask layer from oxidation during removal of the resist layer.

7. A method for forming a metal pattern in a substrate, the substrate having a dielectric constant less than about 4, the method comprising the steps of:

depositing a lower hardmask layer on the substrate, the lower hardmask layer having a dielectric constant less than about 4.5;

forming a protective layer in a region of the lower hardmask layer adjacent to a top surface thereof;

depositing a top hardmask layer on the lower hardmask layer, the top hardmask layer having a thickness less than about 200 Å;

forming a first opening in the top hardmask layer in accordance with a first pattern, thereby exposing a portion of the lower hardmask layer;

forming a second opening in said portion of the lower hardmask layer in accordance with a second pattern, thereby exposing a portion of the substrate;

forming an opening in the substrate;

depositing metal in the opening in the substrate; and

removing the top hardmask layer.

8. A method according to claim 7, wherein the material of said top hardmask layer is selected from the group consisting of refractory metals, refractory metal nitrides, refractory metal alloys, doped amorphous silicon and doped silicon.

9. A method according to claim 7, wherein the lower hardmask layer is of a material selected from the group consisting of SiC:H, SiCOH, SiCNH, carbon-doped oxide, organosilicate glass, silicon oxycarbide, amorphous hydrogenated silicon carbide and amorphous hydrogenated silicon carbide/nitride.

10. A method according to claim 7, wherein said step of depositing metal further comprises depositing excess metal overlying the top hardmask layer, and further comprising the step of removing the excess metal by polishing the metal in a chemical-mechanical polishing (CMP) process, a polishing rate of the top hardmask layer being less than a polishing rate of the metal.

11. A method according to claim 7, wherein

said step of forming the first opening includes depositing a resist layer on the top hardmask layer and subsequently removing the resist layer therefrom, and

said step of forming a protective layer comprises exposing the lower hardmask layer to a plasma, thereby forming a protective nitride layer in said region which protects the lower hardmask layer from oxidation during removal of the resist layer.

12. A method according to claim 7, wherein

said step of forming the first opening includes depositing a resist layer on the top hardmask layer and subsequently removing the resist layer therefrom, and

said step of forming a protective layer comprises exposing the lower hardmask layer to a plasma which densifies the lower hardmask layer in said region, so that the protective layer protects the lower hardmask layer from oxidation during removal of the resist layer.

13. A method according to claim 7, wherein

the lower hardmask layer is deposited under conditions such that the material of the lower hardmask layer has increased density in said region adjacent to the top surface of the lower hardmask layer.

14. A method according to claim 7, wherein

said step of forming the first opening includes depositing a resist layer on the top hardmask layer and subsequently removing the resist layer therefrom, and

the resist layer is removed in a non-oxidizing resist strip process.

15. A method according to claim 7, wherein the protective layer has a thickness of approximately 100 Å.

16. A method for forming a metal pattern in a substrate, the substrate having a dielectric constant less than about 4, the method comprising the steps of:

depositing a lower hardmask layer on the substrate, the lower hardmask layer having a dielectric constant less than about 4.5;

depositing a top hardmask layer on the lower layer, the top hardmask layer having a thickness less than about 200 Å;

forming a first opening in the top hardmask layer in accordance with a first pattern, thereby exposing a portion of the lower hardmask layer;

forming a second opening in said portion of the lower hardmask layer in accordance with a second pattern, thereby exposing a portion of the substrate;

forming an opening in the substrate;

depositing metal in the opening in the substrate; and

removing the top hardmask layer,

wherein said step of forming the first opening further comprises depositing a resist layer on the top hardmask layer and subsequently removing the resist layer therefrom, and

the resist layer is removed in a non-oxidizing resist strip process.

17. A method according to claim 16, wherein the material of said top hardmask layer is selected from the group consisting of refractory metals, refractory metal nitrides, refractory metal alloys, doped amorphous silicon and doped silicon.

18. A method according to claim 16, wherein the lower hardmask layer is of a material selected from the group consisting of SiC:H, SiCOH, SiCNH, carbon-doped oxide, organosilicate glass, silicon oxycarbide, amorphous hydrogenated silicon carbide and amorphous hydrogenated silicon carbide/nitride.

19. A method according to claim 16, wherein said step of depositing metal further comprises depositing excess metal overlying the top hardmask layer, and further comprising the step of removing the excess metal by polishing the metal in a chemical-mechanical polishing (CMP) process, a polishing rate of the top hardmask layer being less than a polishing rate of the metal.

20. A method according to claim 16, wherein the resist strip process is a plasma process with a reducing chemistry.